Executive Summary

Background

The City of Norman (City) operates a wastewater treatment plant (WWTP) that treats all of the wastewater generated in the Norman sanitary sewer service area before discharging to the Canadian River. The total treatment capacity of the existing facility is 12 million gallons per day (mgd). The annual average daily flow treated by the WWTP in 2010 was approximately 11 mgd. The last major upgrade to the plant's biological process was performed in 2000, which added an activated sludge treatment process to the existing fixed film treatment process.

The City adopted the *Wastewater Master Plan* in September of 2001, which used extensive hydraulic modeling to project the expected flow rate for the full build-out of each sewer basin in the Norman sanitary sewer service area, as defined by the *Norman 2020 Land Use and Transportation Plan*. The individual sewer basins can be divided into two main service basins: north and south. The two basins are divided by a ridge that runs through Norman from east to west, which separates sewersheds that naturally flow to the south from those that naturally flow to the north. The *Master Plan* recommends expansion of the existing WWTP to treat the wastewater flow that will be generated by full build-out of the southern sanitary sewer service area. This Engineering Report identifies the improvements required to upgrade the Norman WWTP to treat the wastewater flow generated by the full build-out condition in the southern area.

Project Planning Area

The first step in conceptualizing these improvements is to quantify the flow rate expected in the project planning area. Population projections were gathered from the *Norman 2025 Plan*, which was recently updated and adopted by the City in 2004, and is periodically updated by Council action. According to the planning document, there are eight (8) future service areas identified for the south basin where sanitary sewer is not currently provided, but will be required for future development. The projected population of those future service areas plus the projected population for full build-out of the existing south basin service areas is equal to a population equivalent of 159,388.

The complete report (420 pages) is on file in the City Clerk's Office

Annual average per-capita flow was determined with extensive hydraulic modeling of the wastewater system as part of the *Master Plan*. The study projected an average per-capita flow for the entire Norman sewer basin of 102.3 gallons per capita per day (gcd). As shown in Table ES-1 below, the projected flow rate is simply the projected population multiplied by the per-capita flow.

Table ES-1
Projected Design Flow

Norman 2025 Plan Projected Build-Out Population	Per-Capita Flow (gcd)	Projected Flow (mgd)	**Design Flow (mgd)**
159,388	102.3	16.3	**17**

The design flow of 17 mgd includes an approximate 5% reserve capacity, and is used to determine the required treatment capacity of each of the proposed process units at the Norman WWTP for full build-out capacity. The City of Norman is projected to reach the 17 mgd full build-out treatment capacity in 2041. The City is currently allocated 16 mgd of effluent discharge to the Canadian River. Because the need for additional capacity does not occur within 20 years, it is not possible for DEQ to approve an increase to the design flow in the 208 Plan. As such, it is necessary that the proposed improvements identified herein have a maximum total treatment capacity of 16 mgd. However, where a financial advantage can be gained, the proposed expansion of certain process units in this project may be to the full build-out capacity of 17 mgd.

Existing Facilities Assessment

The next step in the conceptual design is to determine the capacity and condition of each component of the existing facility. Figure ES-1 shows a diagram of the existing WWTP site layout. Table ES-2 includes an itemized list of major plant components related to the liquid treatment process. Equipment described as "Good" is properly sized, has no major mechanical or structural issues, and has several years of useable operating life remaining. Equipment described as "Fair" is in working condition, but may be nearing the end of its service life or in need of minor repair. Equipment described as "Poor" is either not functioning properly, is not sized correctly, or has reached the end of its useable operating life.

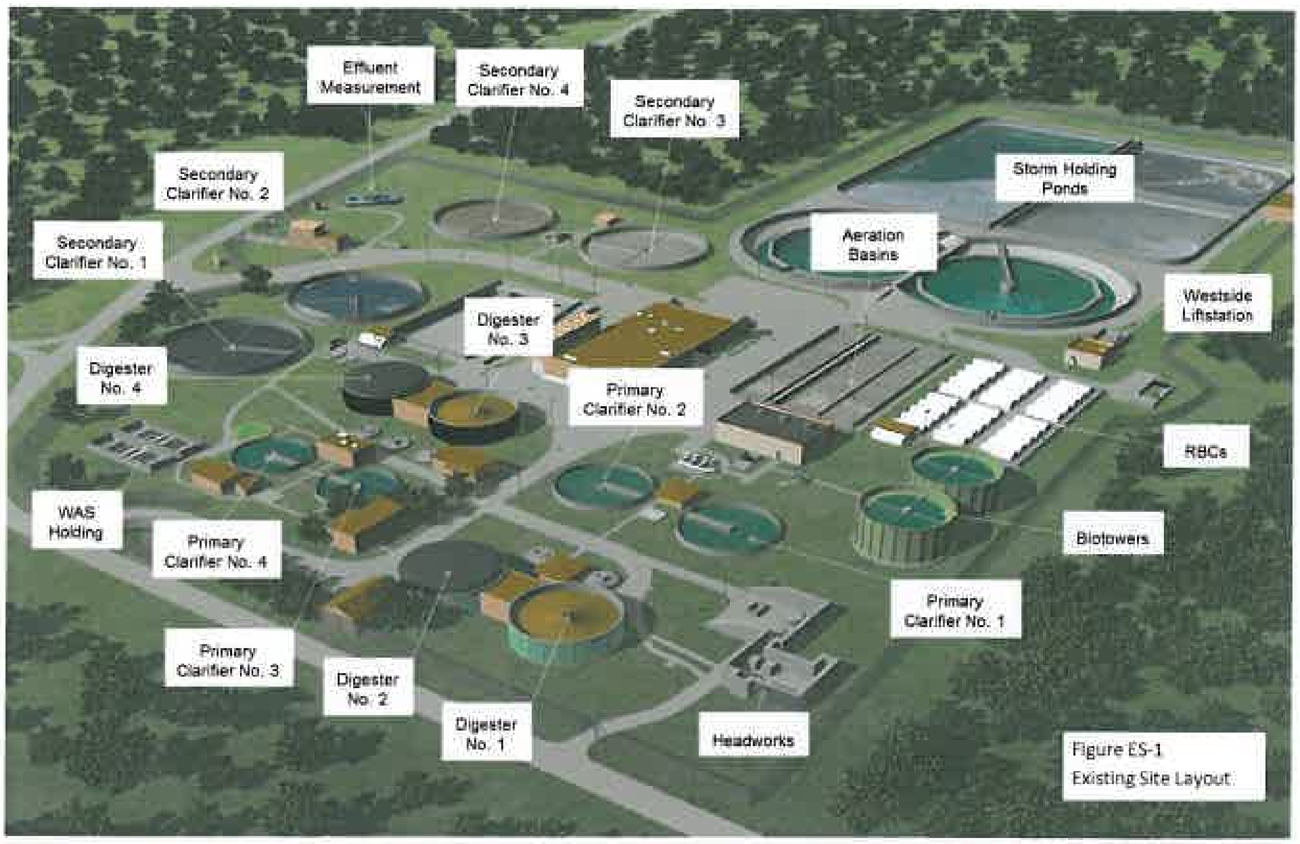

Figure ES-1
Existing Site Layout

Preliminary Treatment

Preliminary treatment units include influent screens and grit removal units, which are necessary to remove rags and grit from the influent in order to protect and maintain downstream equipment. As can be seen in Table ES-2, most of the preliminary treatment units were upgraded in 2004 and are considered in good condition, with only minor improvements to the screening conveyors necessary. The influent flow measurement flume is outdated and hydraulically limited at the proposed future flow rate and in need of replacement.

Primary Treatment

Primary treatment is accomplished with four primary clarifiers. Primary clarification is used to remove particulate solids and organics from the wastewater stream to reduce the load on downstream biological treatment units. The primary clarifiers, constructed in 1957 and 1964, are outdated and in need of major mechanism replacements and minor concrete rehab in all four existing units.

Secondary Treatment

Secondary treatment consists of the biological treatment process, which converts dissolved organic pollutants in the wastewater to a biomass. The biological treatment process is considered the heartbeat of the plant and is crucial to maintaining compliance with effluent requirements. The existing activated sludge process was constructed in 2000 and is in good shape, but replacement of aeration diffusers is currently past due. The WWTP is also equipped with a fixed film biological process, which is no longer approved for secondary treatment. These processes were originally constructed in the late 1980s and early 1990s and are scheduled to be removed as part of the Phase 2 Improvements.

The second half of secondary treatment is the physical removal of the accumulated biomass from the flow stream. This removal is accomplished with four secondary clarifiers. Two of the clarifiers were constructed with the activated sludge basins in 2000 and are in good condition. The other two clarifiers were originally constructed with the fixed film plant in the late 1980s, and were rehabbed in 2000 but are considered too shallow for use in a suspended growth system.

Once removed from the treatment stream, a portion of biomass is recycled back through the biological treatment process. The recycle pumps currently require ongoing maintenance to operate, and are due for replacement. Along with the solids removed by the primary clarifiers, the remaining biomass must be wasted from the system and further treated before ultimate disposal through land application. Table ES-3 includes an itemized list of major plant components related to the solids handling process.

Table ES-2
Major Liquid Train Components

Level	Process	Component	Year of Construction	Condition
Preliminary Treatment	West Side Lift Station	2- Mechanical Finescreen, 20 mgd/ea	2004	Good
		1 - Screenings Conveyor	2004	Good
		3 - Vertical Centrifugal Pumps, 4,700 gpm/ea	2004	Good
	Headworks	2- Mechanical Finescreen, 72 mgd/ea	2004	Good
		1 - Screenings Conveyor	2004	Poor
		1 - Vortex Grit Chambers, 30 mgd	2004	Good
		1 - Vortex Grit Chambers, 12 mgd	2004	Good
	Flow Measurement	1 - Parshall Flume, 18"	1964	Poor
		1 - Parshall Flume, 24"	1965	Poor
Primary Treatment	Primary Clarifiers	2 - 70-ft Primary Clarifiers, SWD - 10-ft	1957	Fair
		2 - 60-ft Primary Clarifiers, SWD - 9.5-ft	1964	Fair
		2 - Primary Clarifier Splitter Box	1957/1964	Fair
Secondary Treatment	Activated Sludge Process	3 - Aeration Basin, 184-ft x 40-ft x 16-ft SWD /ea	2000	Good
		3 – Diffused Air Systems, 2,026 diffuser discs per basin	2000	Poor
		4 - 350 HP Blowers, 6,550 scfm/ea	2000	Good
		4 - Blower VFDs, 350 HP	2011	Good
	Rotating Biological Contactor	1 - RBC Basin, 472,991 gallons	1992	Out of Service
	Secondary Clarifiers	2 - 126-ft Secondary Clarifiers, SWD - 7.25-ft	1988	Poor
		2 - 125-ft Secondary Clarifiers, SWD - 14.5-ft	2000	Good
	RAS/WAS Pumping	2 - 60 HP Vertical Turbine Pumps, 4,600 gpm/ea	2000	Poor
	Effluent Flow Measurement	1 – Parshall Flume, 72"	2010	Good
	Non-Potable Pumping System	2 – Non-Potable Pumps	2010	Good
	Discharge Piping	1 – 54" Discharge Line, 3000 LF	1988	Fair

Table ES-3
Major Solids Train Components

Level	Process	Component	Year of Construction	Condition
Solids Handling	Primary Sludge Thickening	4 - 18-ft Gravity Thickeners, SWD - 10-ft	1963	Fair
		4 – Thickened Primary Sludge Pumps, 200 gpm/ea	2006/2009	Good
	WAS Storage	1 - WAS Storage Tank, 77-ft x 48-ft x 14-ft	1972	Fair
		1 – Diffused Air Supply System	1972	Fair
		2 - WAS Centrifuge Feed Pumps, 220 gpm/ea	2010	Good
	WAS Thickening	1 - Thickening Centrifuge, 790 pph	2010	Good
		1 - TWAS Pump, 34 gpm	2010	Good
	Anaerobic Digestion	2 - 70-ft Primary Digesters, SWD - 22-ft	1963/1988	Fair
		2 - Primary Fixed Covers	2010	Good
		2 - 70-ft Secondary Digesters, SWD - 22-ft	1963/1988	Fair
		2 - Secondary Floating Covers	1963/1988	Poor/Fair
		2 - Primary Mixing Pumps, 2,300 gpm/ea	2010	Good
		2 – Sludge Heating System, 750,000 Btu/hr/ea for Digesters 1 & 2	2011	Good
		2 – Sludge Heating System, 500,000 Btu/hr/ea for Digesters 3 & 4	1988	Fair
	Cogeneration	1 – Cogenerator, 450 kW	1991	Poor
	Sludge Dewatering	1 - Dewatering Centrifuge, 1,800 pph	2010	Good
		2 - Digested Sludge Feed Pumps, 200 gpm/ea	2010	Fair
		1 - Cake Conveyor	2010	Good

Solids Handling

Waste activated sludge (WAS) is pumped to a holding tank prior to mechanical thickening via centrifuge. Thickened WAS is pumped to one of two primary anaerobic digesters, where it combines with gravity thickened primary clarifier solids for treatment prior to disposal. The anaerobic digestion process is mandated before the biosolids can be disposed of via land application. Various components of the digesters have been replaced over time. The most critical need has been created by the failed floating cover on Digester No. 1, which was originally constructed in the 1960s.

Digested solids are pumped to a sludge dewatering centrifuge, where the solids are dewatered prior to land disposal. By concentrating the sludge stream to approximately 20% solids, the total volume of solids requiring disposal is greatly reduced. The dewatering centrifuge was installed as part of the 2010 solids handling project and is in good condition.

The solids handling process is a major concern for plant operators. Because of the delay between the construction of the activated sludge process and construction of the solids handling improvements, much of the excess biological solids have been stored throughout the plant within the treatment units. The excess biomass has forced the operations staff to operate several processes well outside of their design range. Though the staff has managed to maintain compliance despite these difficulties, the effluent water quality has slowly deteriorated over recent years as shown in Figure ES-2, demonstrating the critical need for facility improvements.

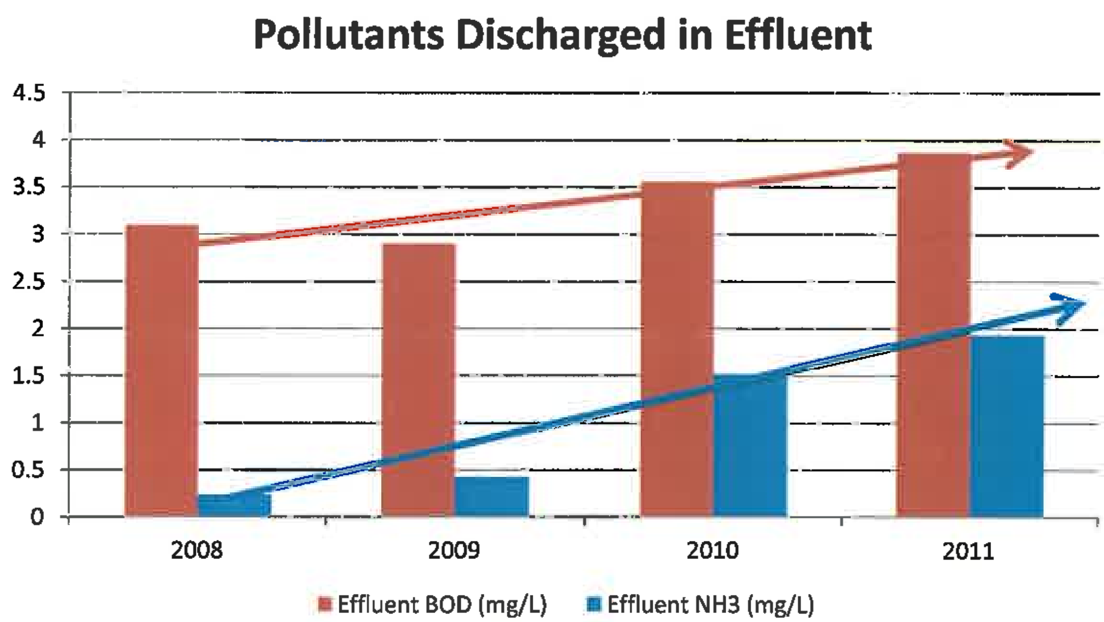

Figure ES-2
Effluent BOD and Ammonia, 2008-11

Need for Project

Section 4 of the Engineering Report identifies the needs for the project. These drivers can be divided into four distinct categories:

- Regulatory Driven Improvements
- Operation and Maintenance Needs
- Capacity Upgrades
- Future Water Re-Use Opportunities

Regulatory Driven Improvements

The regulatory driven improvements are necessary to meet the latest Oklahoma Pollutant Discharge Elimination System permit, which went into effect in July of 2010. The new permit mandates that the City meet new fecal coliform discharge limitations by July 2013, which requires disinfection of the wastewater prior to discharge. The current facility does not have disinfection capabilities. Furthermore, an ongoing Total Maximum Daily Load study of the Canadian River will likely raise effluent dissolved oxygen requirements, requiring a new treatment process to increase the oxygen content of the treated effluent.

Operation and Maintenance Needs

The maintenance related improvements are necessary to replace and/or repair outdated equipment. As shown in Tables ES-2 and ES-3 many of the major components of the treatment process have reached the end of their expected service life and require replacement. Delaying these improvements increases operation and maintenance costs and risks failure of key treatment units, resulting in potential regulatory non-compliance.

Capacity Upgrades

The capacity related upgrades are associated with expanding the WWTP process units to treat the additional flow projected for the full build-out flow condition. The WWTP is currently operating at approximately 92% of its permitted capacity. Many of the treatment units, such as the primary clarifiers, aeration basins, WAS thickening centrifuge, anaerobic digesters, and dewatering centrifuge, are operating at or above the maximum rated capacity. The proposed project expands the treatment capacity at those areas of the plant to meet the current and future needs of the City.

Future Water Re-Use Opportunities

Currently, ODEQ is in the process of developing standards to regulate the practice of water re-use. Norman has been a key advocate in the push for water re-use regulations, and is especially interested in the opportunities available for the use of reclaimed water, since the City does not have adequate water resources to support future potable water needs. As a safe, proven, drought-proof water resource, reclaimed water was considered extensively in the *Master Plan* as a way to offset the growing demand for Norman water, including various non-potable uses or augmentation of existing water resources.

University of Oklahoma Golf Course

To meet the expected requirements of the water re-use regulations and allow widespread re-use, advanced treatment processes would be required at the WWTP. Section 5, Technologies Considered, compares and contrasts the technologies available to meet the advanced treatment requirements for water re-use. Ultimately, a technology has been recommended and a cost estimate provided for each advanced treatment process. Although the identified advanced treatment alternatives are not included in Phase 2 of the WWTP Improvements, the Proposed Project accounts for the future treatment processes and provides footprint and hydraulic head to install them at a later time.

Proposed Project

The proposed project addresses each of the project drivers: regulatory, O&M, and capacity. Following the improvements, the upgraded WWTP will be capable of meeting all existing and immediate future discharge permit requirements at a design average day flow rate of 17 mgd. The major equipment items that are faulty and outdated will be replaced with modern components. Furthermore, all of the identified improvements are fully compatible with future phasing of the advanced treatment processes required for water re-use or any stricter effluent requirements that may be realized in the future. The proposed improvements are shown graphically in Figure ES-3. Each of the proposed improvements is color coded by project driver.

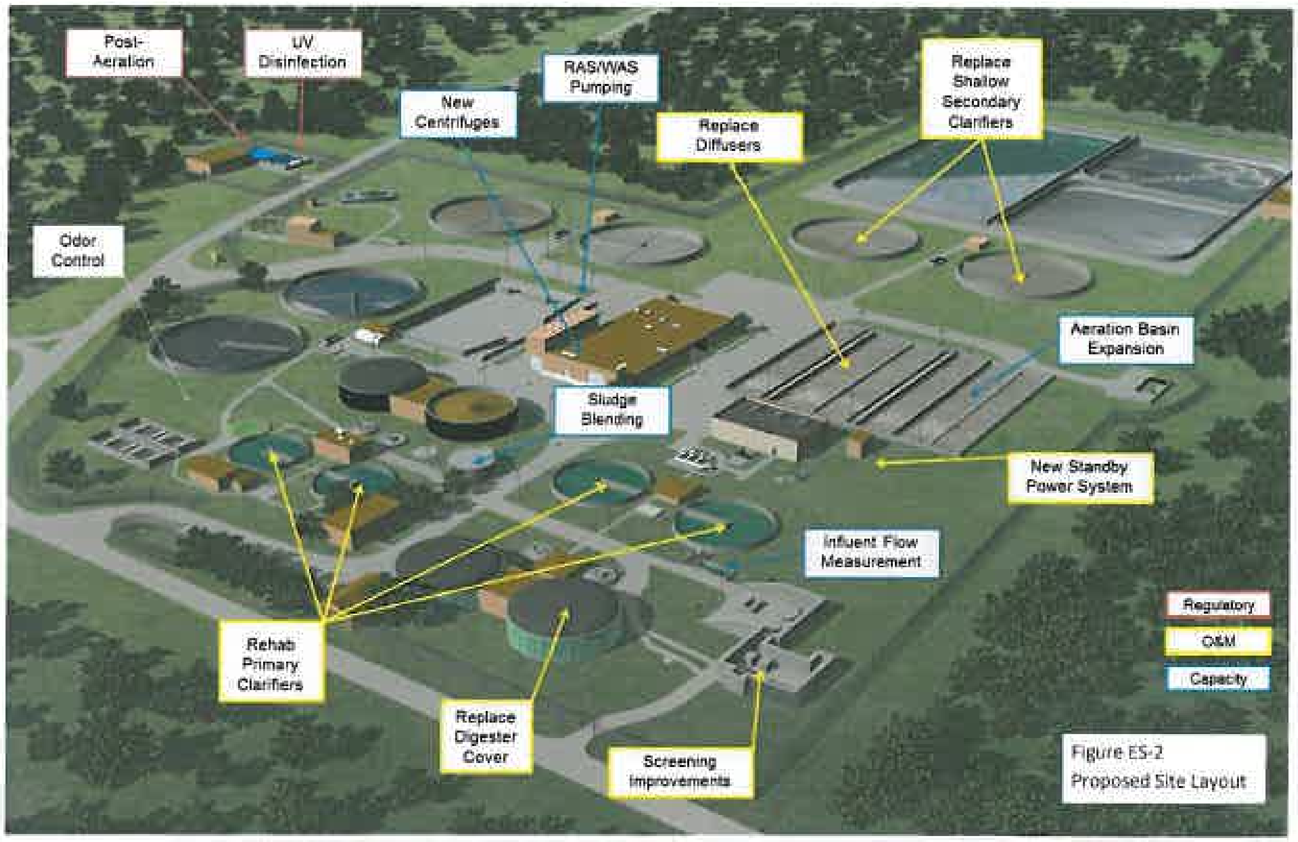

Figure ES-2
Proposed Site Layout

Cost Estimate

Cost opinions were developed for each of the proposed improvements and are summarized in Table ES-4. Each of the line items includes the capital cost, 10% contingency, contractor profit at bidding, escalation to the mid-point of construction, and professional services. At this stage of conceptual design, the cost estimate should be used for planning level, budgetary analysis. The cost estimate will become more accurate as the project progresses into the preliminary and final design phases.

Table ES-4
Proposed Project Cost Estimate

Facility	Total
Screening Improvements	$ 533,000
Influent Flow Metering/Splitting	$ 596,000
Rehab Existing Primary Clarifiers	$ 2,879,000
Primary Clarifier Bypass Line	$ 946,000
New Aeration Basins (3)	$ 10,359,000
Replace Existing AB Diffusers	$ 2,073,000
Secondary Clarifiers (2)	$ 10,720,000
RAS Pumping	$ 551,000
WAS Pumping	$ 788,000
UV Disinfection	$ 5,022,000
Post-Aeration	$ 4,428,000
Parallel Discharge Line	$ 1,716,000
WAS Thickening (2)	$ 3,722,000
Sludge Blending	$ 1,359,000
Anaerobic Digestion	$ 1,326,000
Odor Control	$ 3,688,000
Standby Power	$ 1,642,000
TOTAL PROJECT COST	**$ 52 Million**

Capacity

Equipment

Regulatory

The capital expenditures are summarized by Project Driver in Table ES-5. Odor control was specifically requested by City staff to be included in this project due to rising numbers of complaints. Because odor control is not related to the previously described drivers, the cost is provided on a separate line item.

Table ES-5
Cost Breakdown By Project Driver

Capacity	$ 20,037,000
Equipment	$ 19,173,000
Regulatory	$ 9,450,000
Odor Control	$ 3,688,000
Total	**$ 52 Million**

Conclusion

Following an extensive review of available technologies and a comparison of different feasible alternatives, it is recommended that the City of Norman proceed with the proposed project, which will expand the total rated treatment capacity to 16 mgd. Furthermore, the proposed project completes the upgrade of much of the facility to the 17 mgd treatment capacity needed for full build-out of the south sewer basin. The proposed improvements also address impending new regulations requiring disinfection and post-aeration. Finally, the proposed project will allow the City the flexibility to pursue advanced treatment in the future, should more stringent regulations or the desire to implement more widespread water re-use occur at a later time.